CLAIMS:

1. A method of tracking amplitude, phase and frequency of a plurality of sinusoidal components in a signal, the method comprising:

a) processing the signal to produce a new set of amplitude and phase estimates using a weighted likelihood method; and

b) processing the signal to produce a new set of frequency estimates using a weighted likelihood method.

2. A method according to claim 1 further comprising sampling the signal to produce a sequence of real-valued samples, wherein steps a) and b) are performed in the digital domain.

3. A method according to claim 1 further comprising sampling the signal to produce a sequence of complex-valued samples, wherein steps a) and b) are performed in the digital domain.

4. A method according to claim 1 wherein steps a) and b) are performed in the continuous time domain.

5. A method of tracking amplitude, phase and frequency of a plurality of sinusoidal components in a signal, the method comprising:

for a current update period:

i) processing the signal to produce a new set of complex amplitude estimates by:

a) for a first input set of estimated complex sinusoidal components, separating components to produce component estimates;

ii) processing the signal to produce a new set of estimated complex sinusoidal components by:

b) for each component of a second input set of estimated complex sinusoidal components, estimating a frequency deviation estimate;

c) adapting a previous set of frequency estimates taking into account an input set of component estimates and the frequency deviation estimates to produce a new set of frequency estimates; and

d) converting the new set of frequency estimates to a new set of estimated complex sinusoidal components.

6. A method according to claim 5 wherein the signal is a sequence of samples and processing is done in the digital domain.

7. A method according to claim 5 wherein the processing is done in the continuous time domain.

8. A method according to claim 5 further comprising:

performing cross-interference cancellation on the component estimates to produce a new set of cross-interference cancelled component estimates, and using the new set of cross-interference cancelled estimates as the input set of component estimates in an execution of step c).

9. A method according to claim 5 further comprising:

performing complex envelope extraction on the component estimates to produce a new set of complex amplitude estimates.

10. A method according to claim 8 further comprising:

performing complex envelope extraction on the cross-interference cancelled component estimates to produce a new set of complex amplitude estimates.

11. A method according to claim 6 wherein:

for the first input set of estimated complex sinusoidal components, separating components to produce component estimates is done using a weighted log-likelihood function with a first weighting sequence;

for each of the second input set of estimated complex sinusoidal components, estimating the frequency deviation estimate is done using a weighted log-likelihood function with a second weighting sequence.

12. A method according to claim 11 wherein the first and second weighting sequences are the same.

13. A method according to claim 9 wherein step i) comprises a first half-iteration, and step ii) comprises a second half iteration, one first half-iteration and one second half-iteration comprising a complete iteration and wherein for each update period, a plurality of complete iterations are performed to produce the new set of complex amplitude estimates and the new set of estimated complex sinusoidal components.

14. A method according to claim 5 wherein the first input set of estimated complex sinusoidal components and the

second set of estimated complex sinusoidal components are initially set to initial values, and thereafter are set to estimated complex sinusoidal components produced by a previous iteration of the method.

15. A method according to claim 10 wherein for each update of the complex amplitude and frequency:

the step of processing samples of the sequence of samples to produce a new set of complex amplitude estimates is performed before the step of processing the sequence of samples to produce a new set of estimated complex sinusoidal components;

the first input set and the second input set of estimated complex sinusoidal components comprise the new set of estimated complex sinusoidal components determined during a previous update period;

wherein the input set of cross-interference cancelled estimates comprises the new set of cross-interference cancelled estimates determined during the current update period.

16. A method according to claim 10 wherein for each update of the amplitude, phase and frequency:

the step of processing the signal to produce a new set of estimated complex sinusoidal components is performed before the step of processing the sequence of samples to produce a new set of complex amplitude estimates;

the input set of component estimates comprises the set of cross-interference cancelled estimates determined during a previous update period;

the first input set of estimated complex sinusoidal components comprises the new set of estimated complex sinusoidal components determined during the current update period and the second input set of estimated complex sinusoidal components comprises the new set of estimated complex sinusoidal components determined during a previous update period.

17. A method according to claim 11 wherein for the first input set of estimated complex sinusoidal components, performing component extraction using a weighted log-likelihood function with the first weighting sequence comprises filtering the samples with a respective component extraction filter tuned to a respective one of the first input set of estimated complex sinusoidal components.

18. A method according to claim 8 wherein performing cross-interference cancellation on the component estimates to produce a new set of cross-interference cancelled component estimates comprises multiplying the component estimates by a cross-interference cancellation matrix.

19. A method according to claim 10 wherein performing complex envelope extraction on the cross-interference cancelled component estimates to produce the new set of complex amplitude estimates comprises multiplying each cross-interference cancelled component estimate by the respective estimated complex sinusoidal component with negative exponent.

20. A method according to claim 11 wherein for each of the second input set of estimated complex sinusoidal components, estimating a frequency deviation estimate using the weighted log-likelihood function with the second

weighting sequence comprises filtering the sampled sequence with a respective frequency deviation filter tuned to the estimated complex sinusoidal component.

21. A method according to claim 5 wherein adapting the previous set of frequency estimates taking into account an input set of component estimates and the frequency deviation estimates to produce a new set of frequency estimates comprises applying an adaptation value to each previous frequency estimate, the adaptation value being a function of both the input set of component estimates and the frequency deviation estimates.

22. A method according to claim 21 wherein applying an adaptation value to each previous frequency estimate, the adaptation value being a function of both the input set of component estimates and the frequency deviation estimates comprises:

determining a partial derivative with respect to each estimated complex sinusoidal component of a function based on the weighted log-likelihood function;

for each frequency estimate, determining the adaptation value from the respective partial derivative.

23. A method according to claim 5 wherein adapting the previous set of frequency estimates taking into account the input set of component estimates and the frequency deviation estimates to produce the new set of frequency estimates comprises:

applying an adaptation value to each frequency estimate in the previous set of frequency estimates, the adaptation value being a function of both the component

estimates and the frequency deviation estimates to produce an intermediate set of frequency estimates;

using the frequency deviation estimates and previous frequency deviation estimates to produce an estimate of chirp for each sinusoidal component;

for each sinusoidal component, combining the frequency deviation estimate and the estimate of chirp to produce a new frequency estimate.

24. A method according to claim 5 wherein converting the new set of frequency estimates to new estimated complex sinusoidal components comprises combining previous estimated complex sinusoidal component estimates with the new frequency estimates.

25. A method according to claim 24 wherein combining the previous estimated complex sinusoidal component estimates with the new frequency estimates comprises:

multiplying each previous estimated complex sinusoidal component estimate by e^(j x new frequency estimate).

26. One or more ASICs (application specific integrated circuit) adapted to implement a method according claim 1.

27. One or more DSPs (digital signal processors) adapted to implement a method according to claim 1.

28. One or more FPGAs (field programmable gate arrays) adapted to implement a method according to claim 1.

29. One or more general purpose processors adapted to implement a method according to claim 1.

30. A combination of at least two circuits selected from a group consisting of ASIC, FPGA, DSP, and general purpose processor adapted to implement a method according to claim 1.

31. A computer readable medium having executable code embodied therein for causing a processing platform to execute a method according to claim 1.

32. An apparatus for tracking amplitude, phase and frequency of a plurality of sinusoidal components in a signal, the apparatus comprising:

a first processing path adapted to process the signal to produce a new set of amplitude and phase estimates using a weighted likelihood method; and

a second processing path adapted to process the signal to produce a new set of frequency estimates using a weighted likelihood method.

33. The apparatus according to claim 32 further comprising:

a sampler adapted to sample the signal to produce a sequence of real-valued samples, wherein the first and second processing paths perform signal processing in the digital domain.

34. An apparatus according to claim 32 further comprising:

a sampler adapted to sample the signal to produce a sequence of complex-valued samples, wherein the first and second processing paths perform signal processing in the digital domain.

35. An apparatus according to claim 32 wherein the first and second processing paths perform signal processing in the continuous time domain.

36. An apparatus for tracking amplitude, phase and frequency of a plurality of sinusoidal components in a signal, the apparatus comprising:

at least one component extraction filter adapted process the signal to produce component estimates for each of a first input set of estimated complex sinusoidal components, each component extraction filter being tuned to a respective one of the first input set of estimated complex sinusoidal components;

at least one frequency deviation filter adapted to process the signal to produce a frequency deviation estimate for each of a second input set of estimated complex sinusoidal components, each frequency deviation filter being tuned to a respective one of the second input set of estimated complex sinusoidal components;

at least one adaptive frequency tracker adapted to produce a new set of frequency estimates by adapting a previous set of frequency estimates taking into account an input set of component estimates and the frequency deviation estimates; and

at least one component generator adapted convert the new set of frequency estimates to a new set of estimated complex sinusoidal components.

37. An apparatus according to claim 36 wherein the signal is a sequence of samples and processing is done in the digital domain, and wherein the at least one component

generator comprises at least one digital controlled oscillator.

38. An apparatus according to claim 36 further comprising:

a cross-interference canceller adapted to perform cross-interference cancellation on the component estimates to produce a new set of cross-interference cancelled component estimates;

wherein the new set of cross-interference cancelled estimates are used as the input set of component estimates to the adaptive frequency tracker.

39. An apparatus according to claim 36 further comprising:

at least one complex envelope estimator adapted to perform complex envelope extraction on the component estimates to produce a new set of complex amplitude estimates.

40. An apparatus according to claim 38 further comprising:

at least one complex envelope estimator adapted to perform complex envelope extraction on the cross-interference cancelled component estimates to produce a new set of complex amplitude estimates.

41. An apparatus according to claim 37 wherein:

each component extraction filter implements a weighted log-likelihood function with a first weighting sequence;

each frequency deviation filter implements a weighted log-likelihood function with a second weighting sequence.

42. An apparatus according to claim 41 wherein the first and second weighting sequences are the same.

43. An apparatus according to claim 36 wherein the first input set of estimated complex sinusoidal components and the second set of estimated complex sinusoidal components are initially set to initial values, and thereafter are set to previously determined estimated complex sinusoidal components.

44. An apparatus according to claim 38 wherein for each time a new set of complex amplitude estimates is produced by the apparatus:

the component extraction filter(s) operate to produce the new set of complex amplitude estimates before the frequency deviation filter(s) operate to produce the new set of estimated complex sinusoidal components;

the first input set and the second input set of estimated complex sinusoidal components comprise the new set of estimated complex sinusoidal components determined during a previous update period;

wherein the input set of cross-interference cancelled estimates comprises the new set of cross-interference cancelled estimates determined during the current update period.

45. An apparatus according to claim 38 wherein for each time a new set of complex amplitude estimates is produced by the apparatus:

the component extraction filter(s) operate to produce the new set of estimated complex sinusoidal components before the frequency deviation filters operate to produce the new set of complex amplitude estimates;

the input set of component estimates comprises the set of cross-interference cancelled estimates determined during a previous update period;

the first input set of estimated complex sinusoidal components comprises the new set of estimated complex sinusoidal components determined during the current update period and the second input set of estimated complex sinusoidal components comprises the new set of estimated complex sinusoidal components determined during a previous update period.

46. An apparatus according to claim 38 wherein the cross-interference canceller produces the new set of cross-interference cancelled component estimates by multiplying the component estimates by a cross-interference cancellation matrix.

47. An apparatus according to claim 40 wherein the complex envelope estimator(s) produce the new set of complex amplitude estimates by multiplying each cross-interference cancelled component estimate by the respective estimated complex sinusoidal component with negative exponent.

48. An apparatus according to claim 36 wherein the adaptive frequency tracker(s) apply an adaptation value to

each previous frequency estimate, the adaptation value being a function of both the component estimates and the frequency deviation estimates.

49. An apparatus according to claim 48 wherein the adaptive frequency tracker(s) determine a partial derivative with respect to each estimated complex sinusoidal component of a function based on a weighted log-likelihood function and for each frequency estimate, determine the adaptation value from the respective partial derivative.

50. An apparatus according to claim 35 wherein the adaptive frequency tracker(s) produce a new set of frequency estimates by applying an adaptation value to each frequency estimate in a previous set of frequency estimates, the adaptation value being a function of both the component estimates and the frequency deviation estimates to produce an intermediate set of frequency estimates, and using the frequency deviation estimates and previous frequency deviation estimates to produce an estimate of chirp for each sinusoidal component, and for each sinusoidal component combine the frequency deviation estimate and the estimate of chirp to produce a new frequency estimate.

51. An apparatus according to claim 36 wherein the component generator(s) convert the new set of frequency estimates to new estimated complex sinusoidal components by combining previous estimated complex sinusoidal component estimates with the new frequency estimates.

52. A computer in combination with a computer readable medium compatible with the computer, cooperatively adapted to implement a method according to claim 1.